DIAGENETIC SCENARIOS FOR POROSITY EVOLUTION IN DEVONIAN DUPEROW CARBONATES, MONTANA AND NORTH DAKOTA

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The numerous carbonate-evaporite sedimentary cycles comprising the Upper Devonian Duperow Formation were deposited under subtidal lagoon to supratidal sabkha conditions which existed over a vast, shallow coastal platform that encompassed the Williston Basin. Hydrocarbon reservoir potential in Duperow carbonates is assessed locally by the degree to which primary and syndepositional porosity was preserved and by the development and retention of secondary porosity. The evolution from inferred primary porosity to existing reservoir porosity was governed by determinate sets of diagenetic events. Any record of porosity evolution may be set forth as provisional scenarios that incorporate time of occurrence and duration, concentration or impact of separate diagenetic functions. The diagenetic processes that operated on these strata, as inherent phenomena of the depositional and burial environments characteristic of particular facies, in turn, were influenced by position within the sedimentary cycle and by the original depositional textures.

Diagenetic products dominate Duperow carbonates, and the processes responsible were complexly multistaged. Nevertheless, the relative sequence of diagenetic events and concurrent porosity evolution can be deduced from diagnostic cement types, void-filling mineral successions including iron-rich and iron-poor calcite or dolomite, recrystallization and aggrading crystal sizes, relict and pseudomorphic replacement structures and a host of cross-cutting and truncation features.

Probably many diagenetic products formed nearly contemporaneously with accumulation of mud-rich Duperow sediments, notably early dolomitization and lithification of aragonite and calcite mud. Primary fenestral, intraskeletal and rare interparticle voids and many secondary voids were filled by calcite vadose crust, drusy rim and equant mosaic cements. Original components were subject to dolomite, pyrite and silica replacement, or recrystallization to form syntaxial rims and neomorphic spar. Laminated, enterolithic, nodular-mosaic, void-filling and replacement forms of anhydrite represent major deterrents to porosity, but these, too, may be replaced or dissolved. Anydrite dissolution may be responsible for many disrupted or brecciated zones. Pressure-solution resulted in stylolites bearing tension fractures and microstylolite swarms accompanied by localized dolomitization. Fracture formation, and aqueous and hydrocarbon leaching are the principal agents of secondary porosity. These processes create molds, vugs, channels and solution-enlarged intercrystalline pores, as well as enhanced permeability.